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Daily stem radial fluctuations in *Eucalyptus* reveals the dynamic of the genetic determinants of trees response to environment

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In trees, daily stem radial fluctuation (DSRF) constitutes a remarkable dynamic trait in response to environmental variations. This circadian rhythm integrates two major processes: i/ the variation in water content determined by transpiration and water absorption, and ii/ cell division in the cambium and subsequent cell expansion (secondary xylem and phloem). DSRF can be measured at a high resolution scale using automatic dendrometers placed on the trunk. While it has been largely studied by ecophysiologists, the genetic basis of DSRF and its interplay with the environment remain largely unknown. The objective of this study was to characterize the genetic architecture of the DSRF in *Eucalyptus*, to learn about the dynamics of genotype-by-environment interaction ($G \times E$). To this end, we analyzed two years of sub-hourly data collected on 220 full-sibs of *E. urophylla* \times *E. grandis*, i.e. about 200,000 data points per tree. Two components of the circadian cycle were studied: the daily amplitude of radial shrinkage (DA), and the difference between successive daily maximum trunk radius values (ΔR). These two variables in relation with environmental factors (temperature, air vapor pressure deficit, soil water content, global radiation) enabled us to study the $QTL \times E$ interaction. At the phenotypic level, DA and ΔR were on average not correlated during the studied period. They showed clear differences in environmental plasticity: DA being positively correlated with several atmospheric variables at the daily scale. Conversely, ΔR showed low correlations with environmental variables at this time scale. These two traits presented a very different genetic architecture suggesting that different genes are indeed involved in DA and ΔR variation. Moreover, the study of the genetic architecture revealed a temporal instability of the genetic control for DA and ΔR . For DA, this instability was clearly related to seasonal variations, and well-illustrated by two QTL regions on the linkage group 3 of the *E. urophylla*. Interestingly, these QTLs colocalized with two major QTLs involved in the genetic control of mature wood properties. These results reinforce the hypothesis that tree response to environmental variation at the juvenile stage could be a key driver of many properties at an older developmental stage.

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